FIG. 1

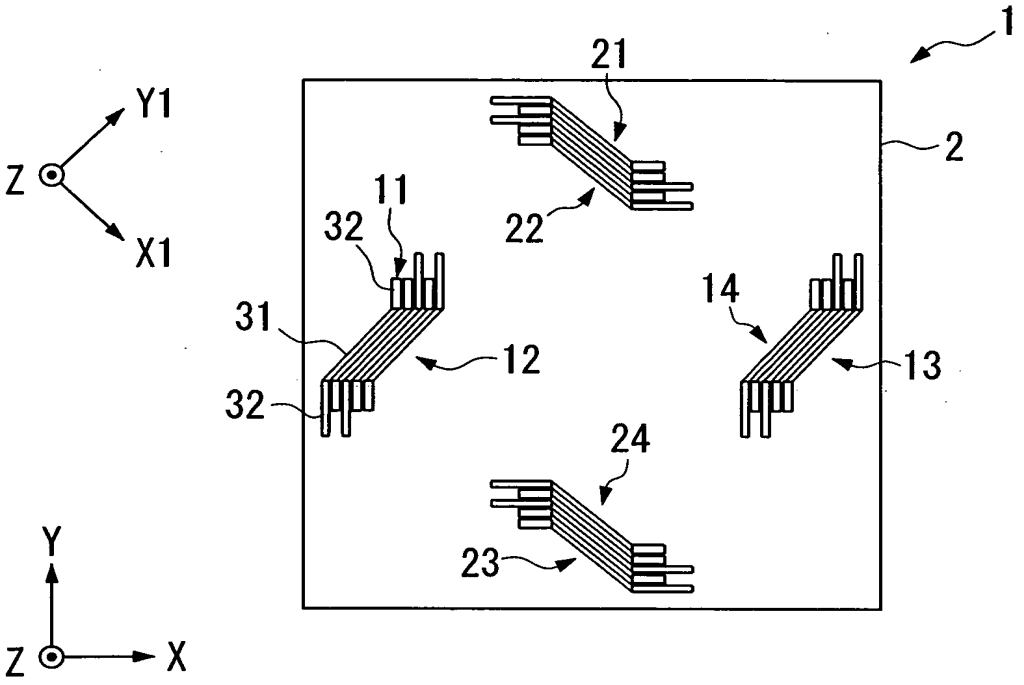
1
21
2
Y1
Z
X1
11
32
22
14
31
12
13
32
24
23
Y
Z
X

FIG. 2

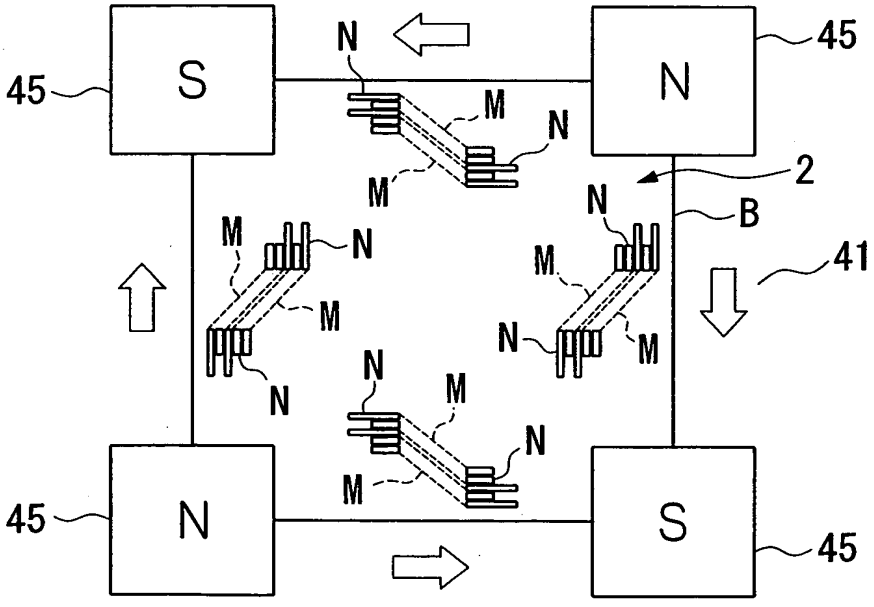
45
S
N
45
N
M
N
M
2
N
B
M
N
M
41
N
M
N
N
M
N
M
45
N
S
45

FIG. 3

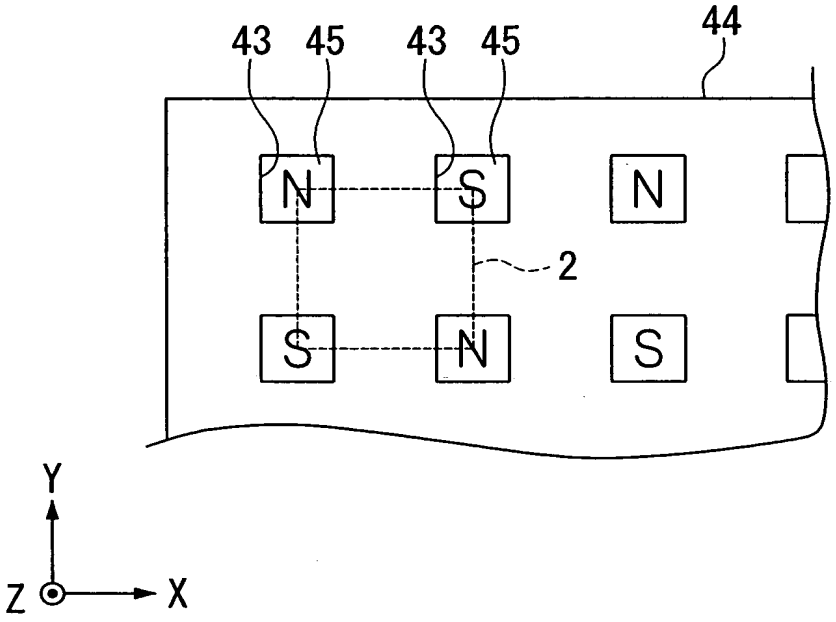

FIG. 4

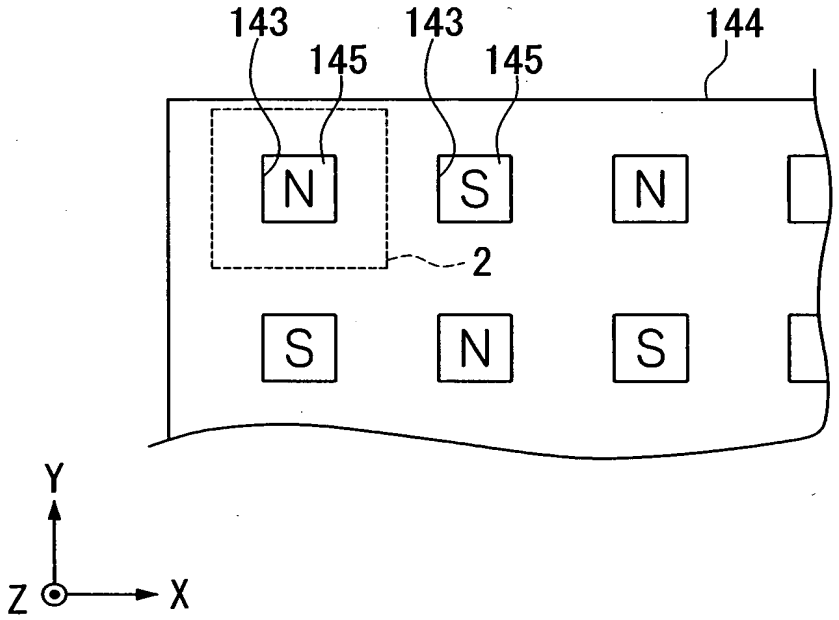

FIG. 5

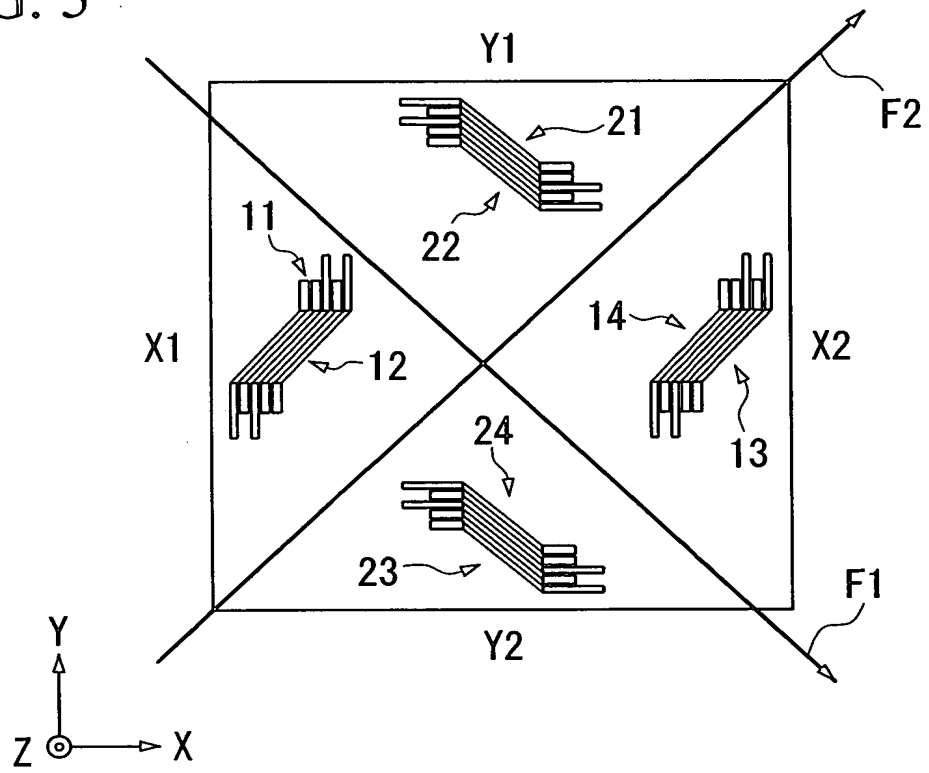
Y1
F2
21
22
11
X1
12
14
X2
13
24
23
F1
Y2
Y
Z
X

FIG. 6

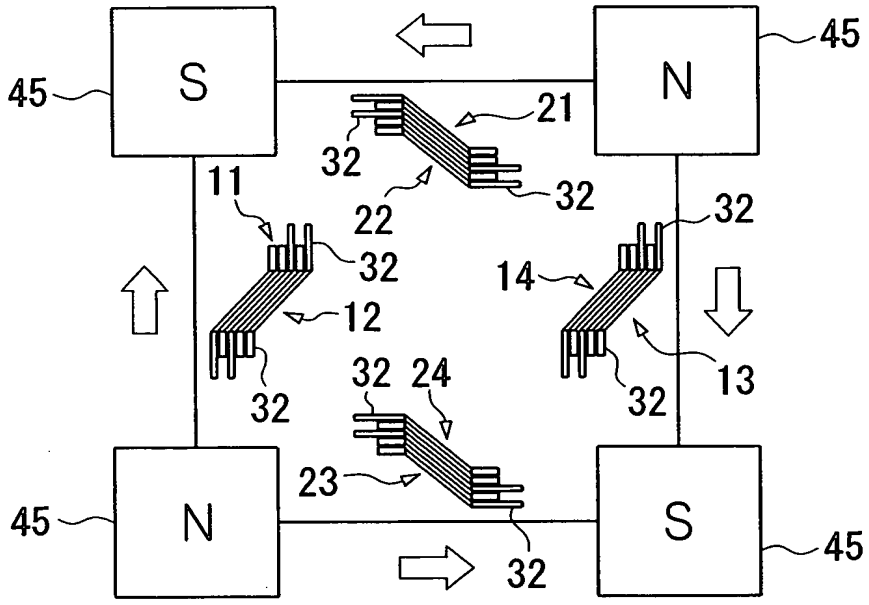
45
S
N
45
21
32
11
22
32
32
14
32
12
32
13
32
24
32
23
45
N
S
45
32

FIG. 7

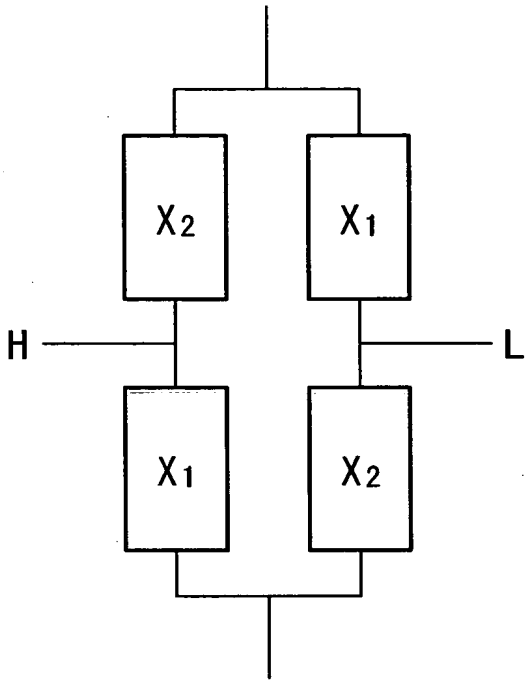

FIG. 8

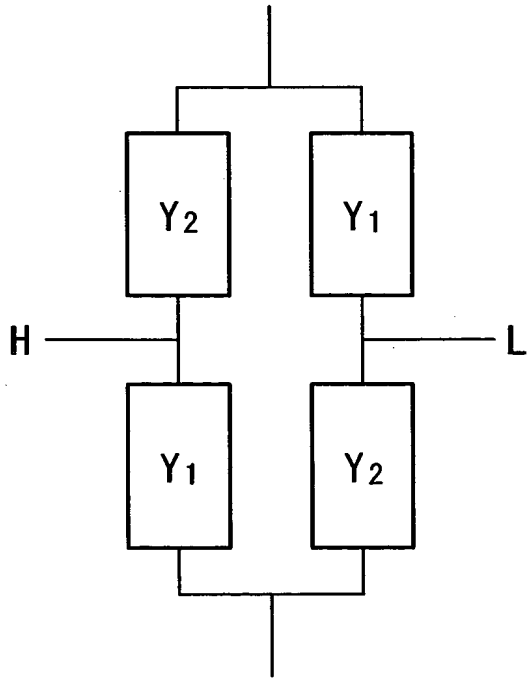

FIG. 9

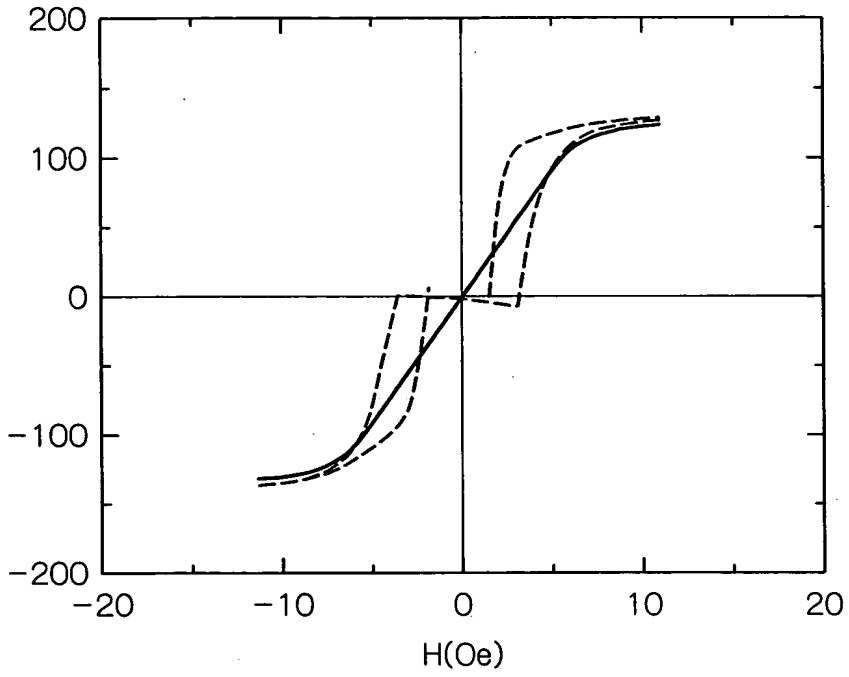
200
100
0
-100
-200
-20
-10
0
10
20
H(Oe)

FIG. 10

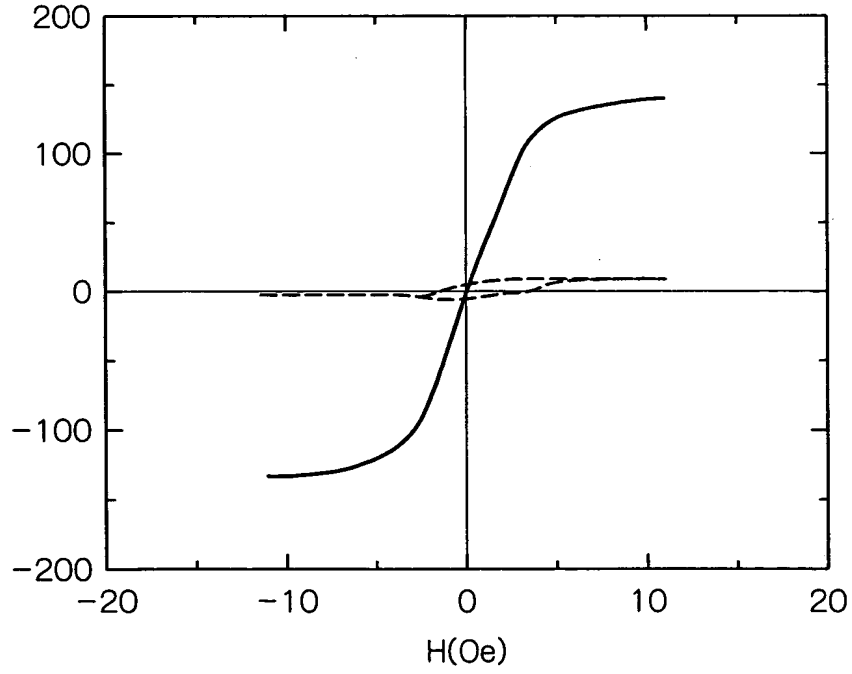
200
100
0
-100
-200
-20
-10
0
10
20
H(Oe)

FIG. 11A

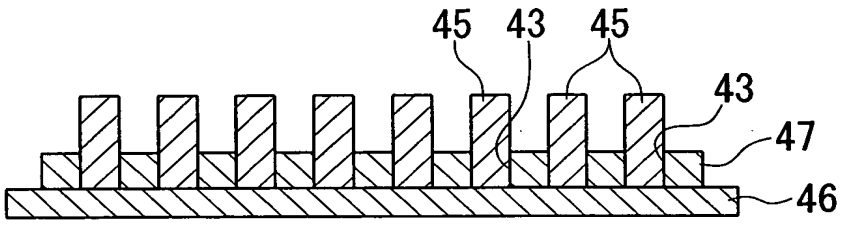

FIG. 11B

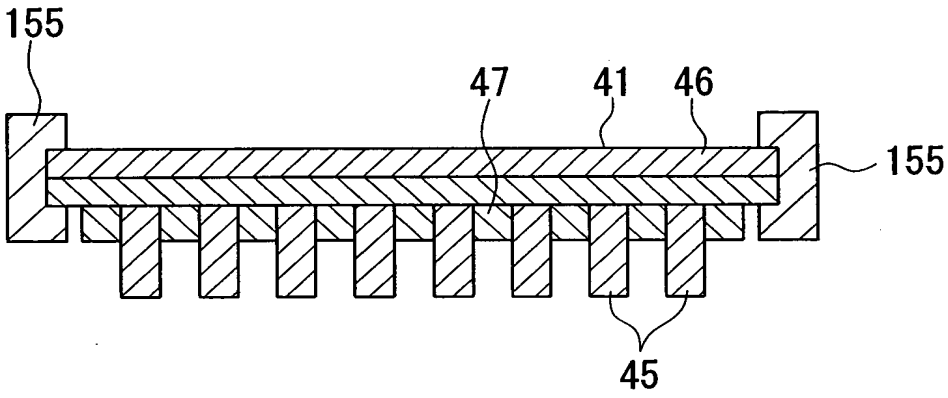

FIG. 12

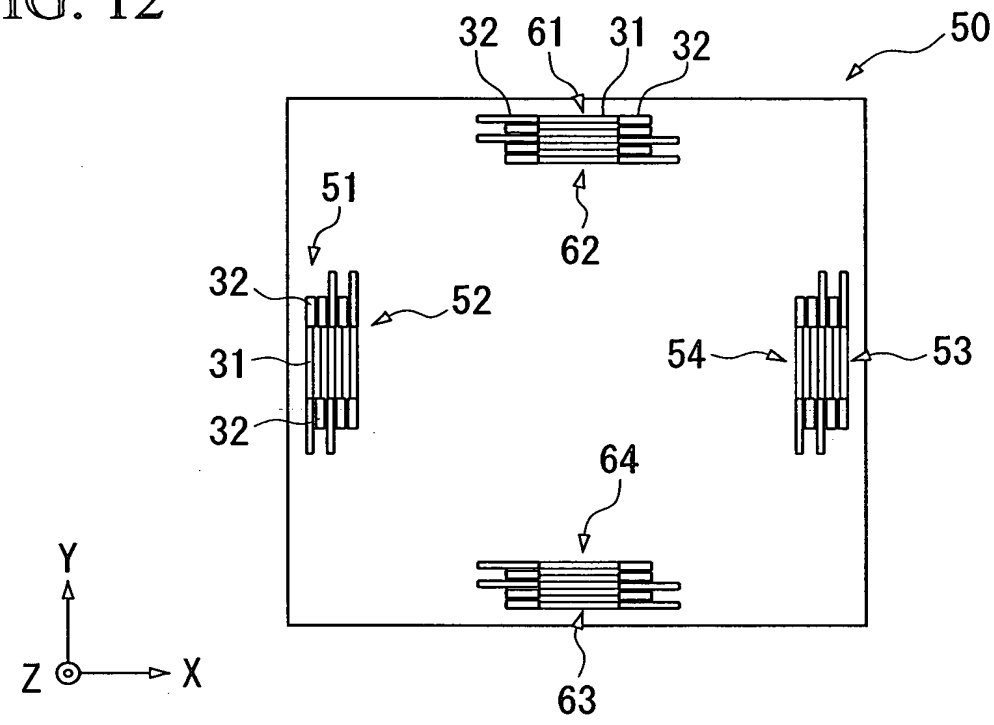

FIG. 13

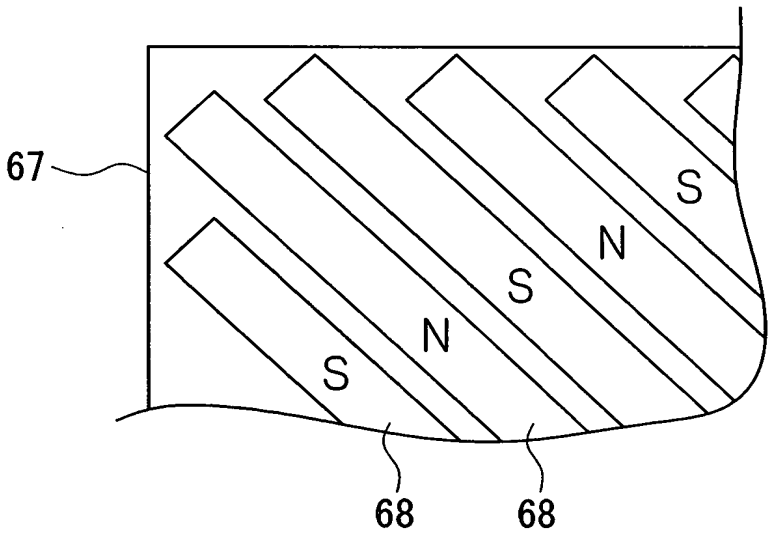

FIG. 14A

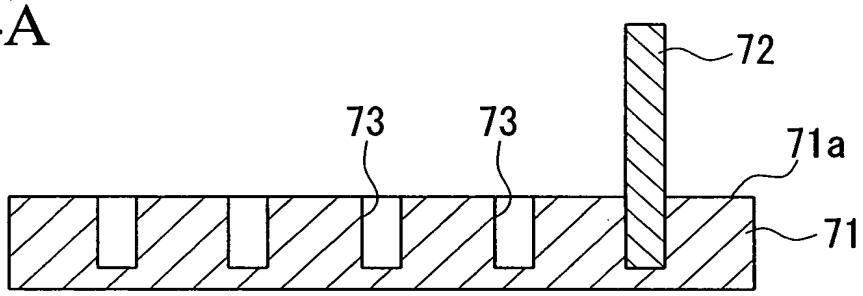

FIG. 14B

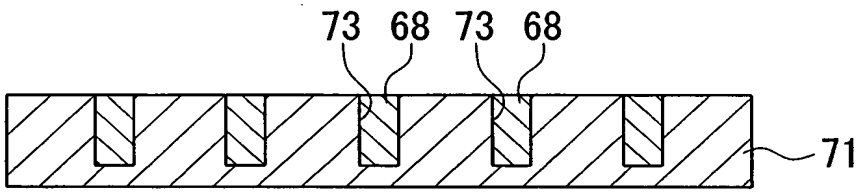

FIG. 15

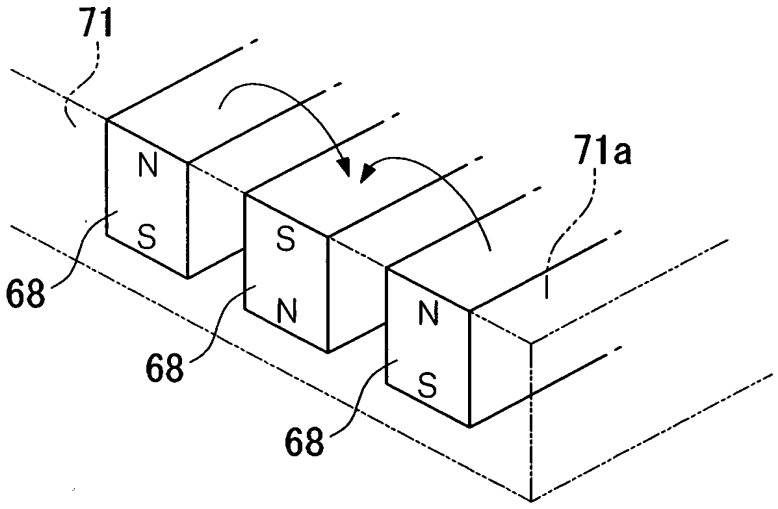

FIG. 16

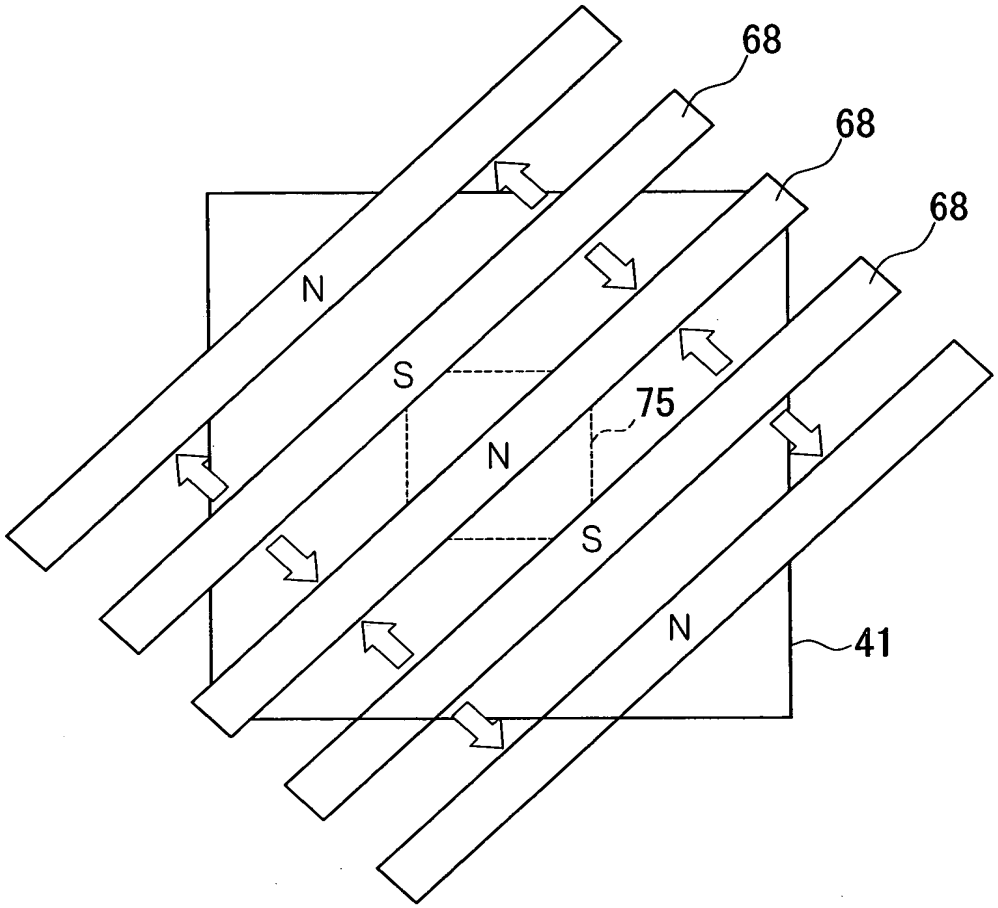

FIG. 17A

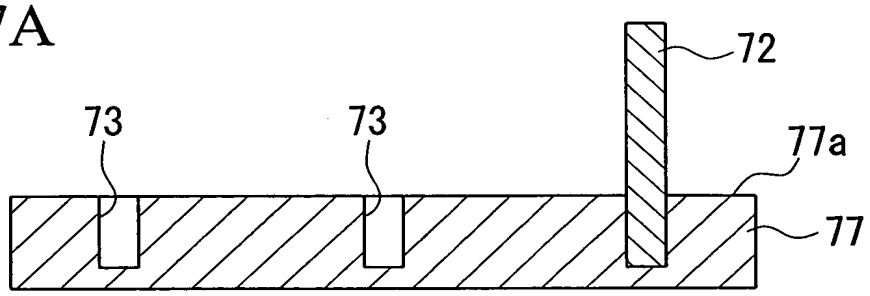

FIG. 17B

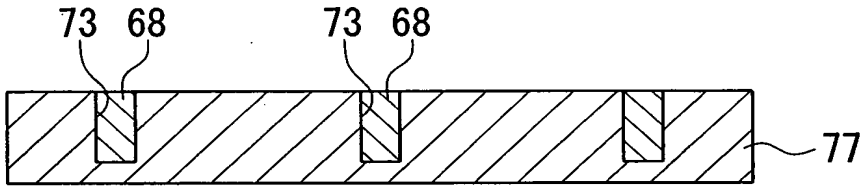

FIG. 18

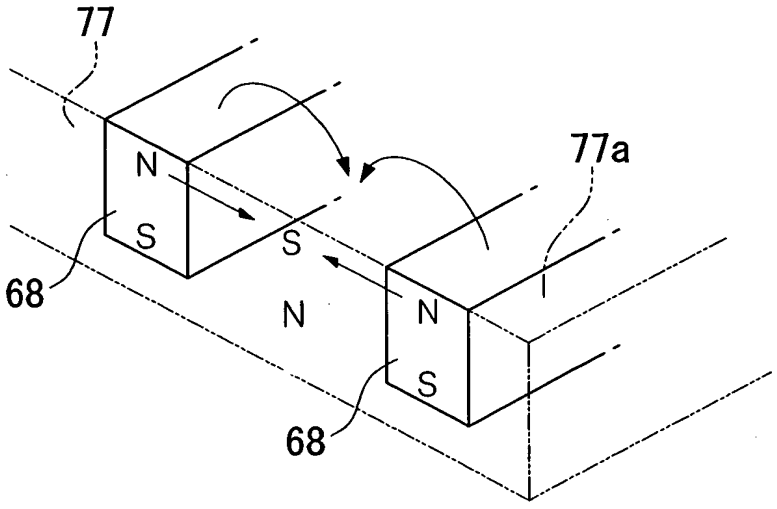

FIG. 19

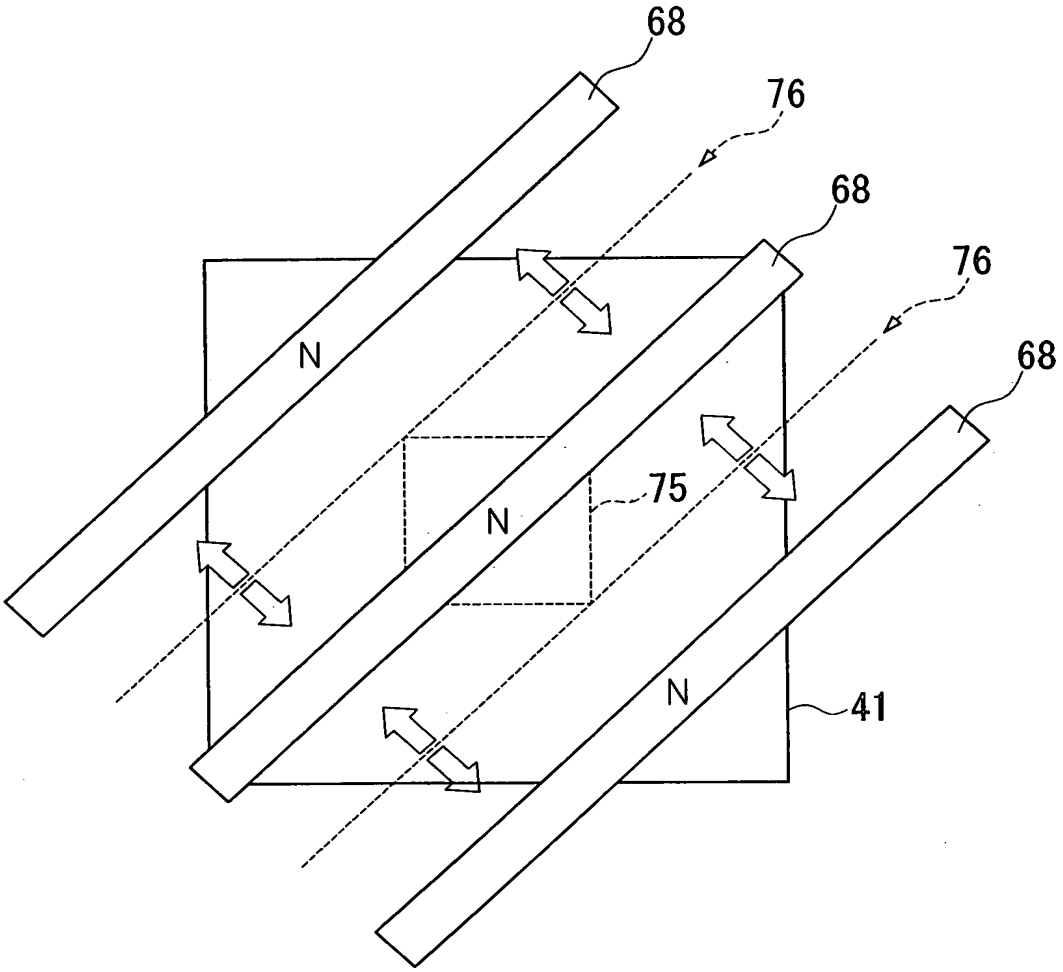

FIG. 20

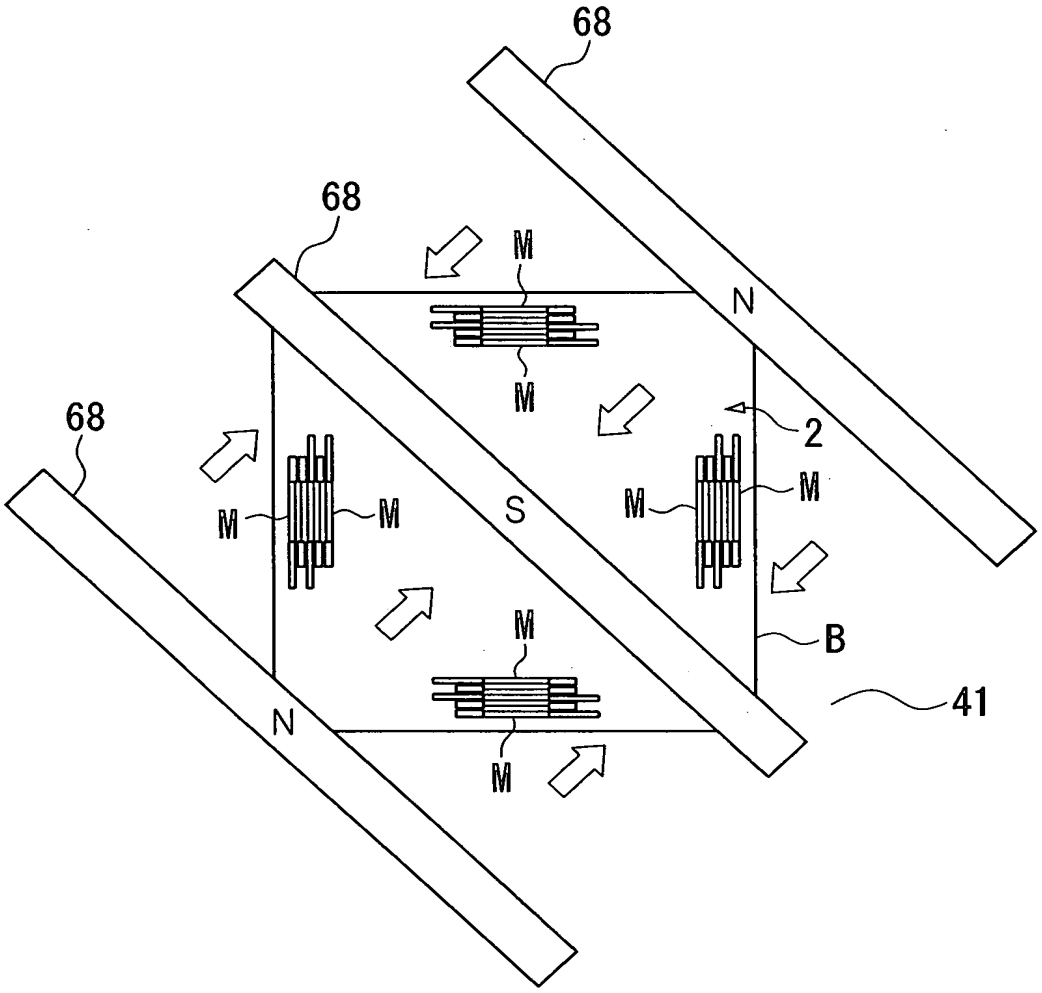

FIG. 21

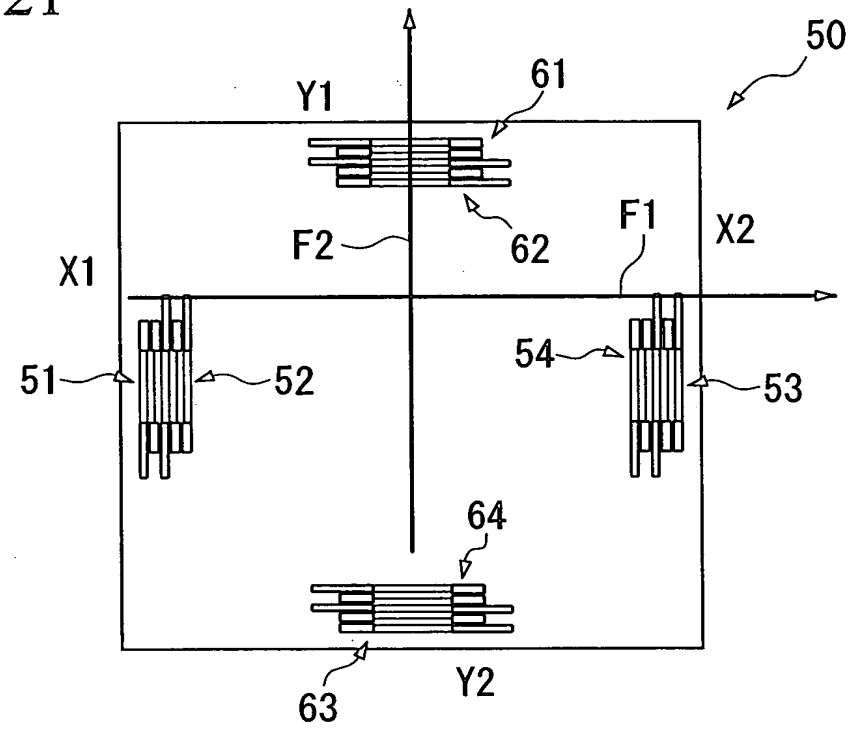
50
61
Y1
62
F2
F1
X2
X1
51
52
54
53
64
63
Y2

FIG. 22

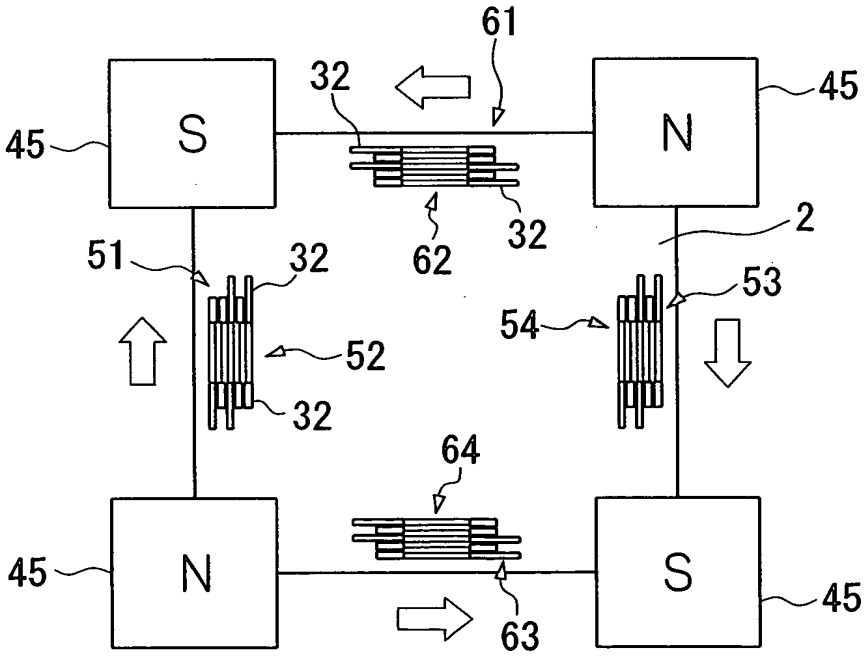
61
32
45
S
N
45
62
32
2
51
32
53
54
52
32
64
45
N
S
45
63

FIG. 23

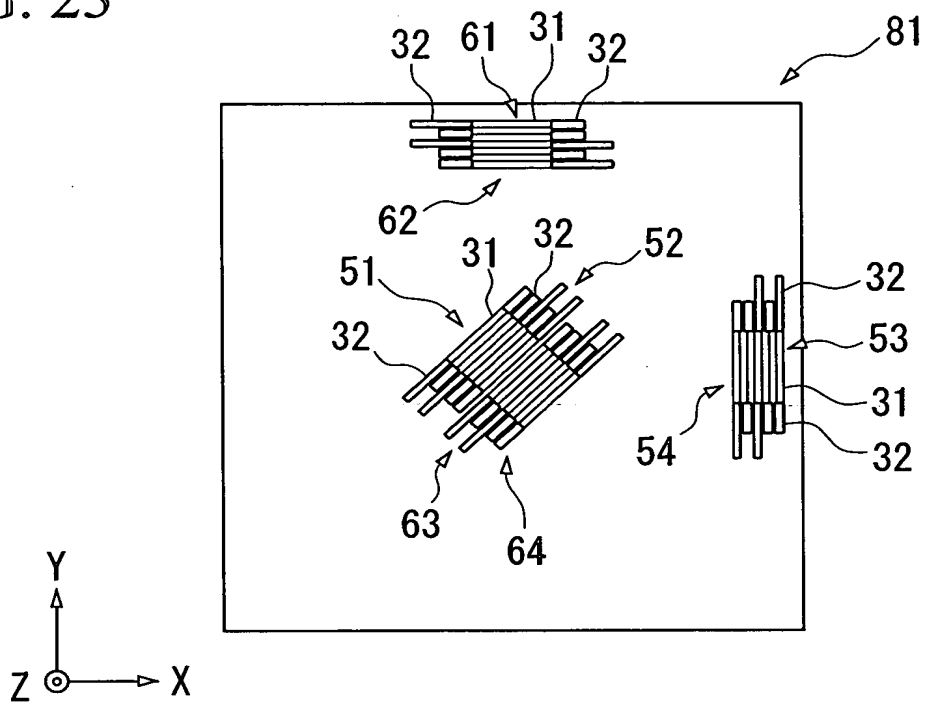
32
61
31
32
81
62
31
32
52
51
32
32
53
31
54
32
63
64
Y
Z
X

FIG. 24

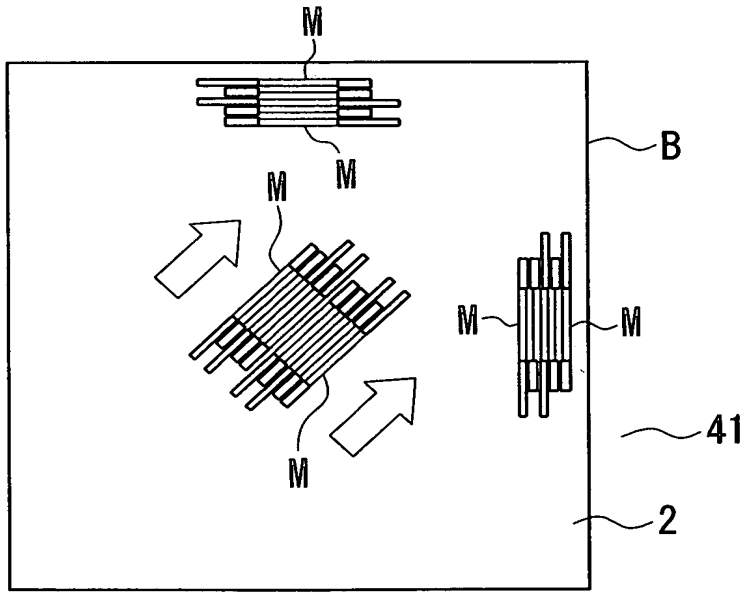
M
M
B
M
M
M
M
M
41
2

FIG. 25

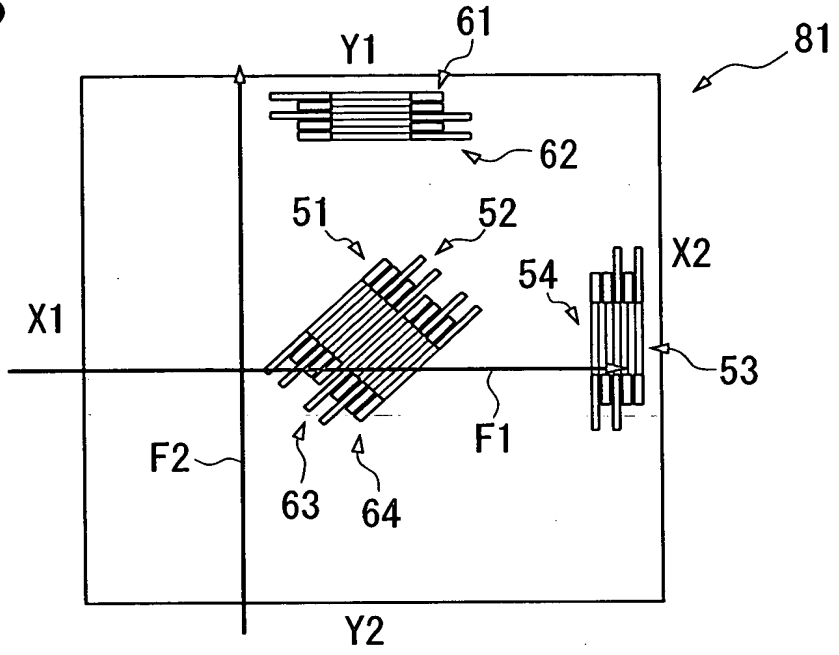
Y1
61
81
62
51
52
X2
54
X1
53
F1
F2
63
64
Y2

FIG. 26

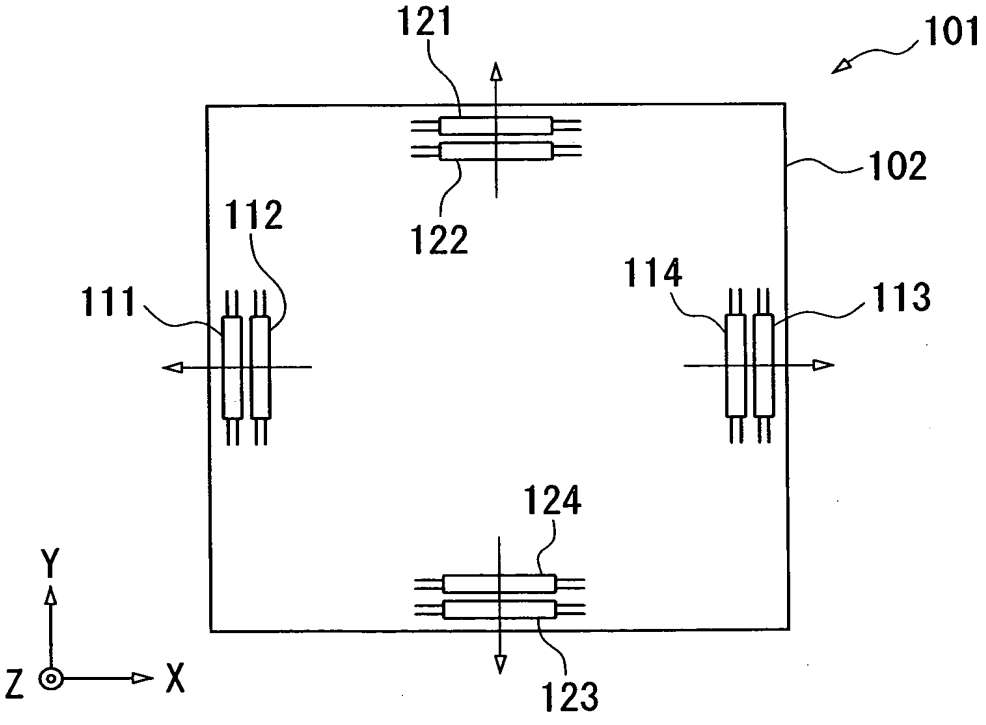
121
101
102
122
112
114
111
113
124
Y
Z
X
123

FIG. 27

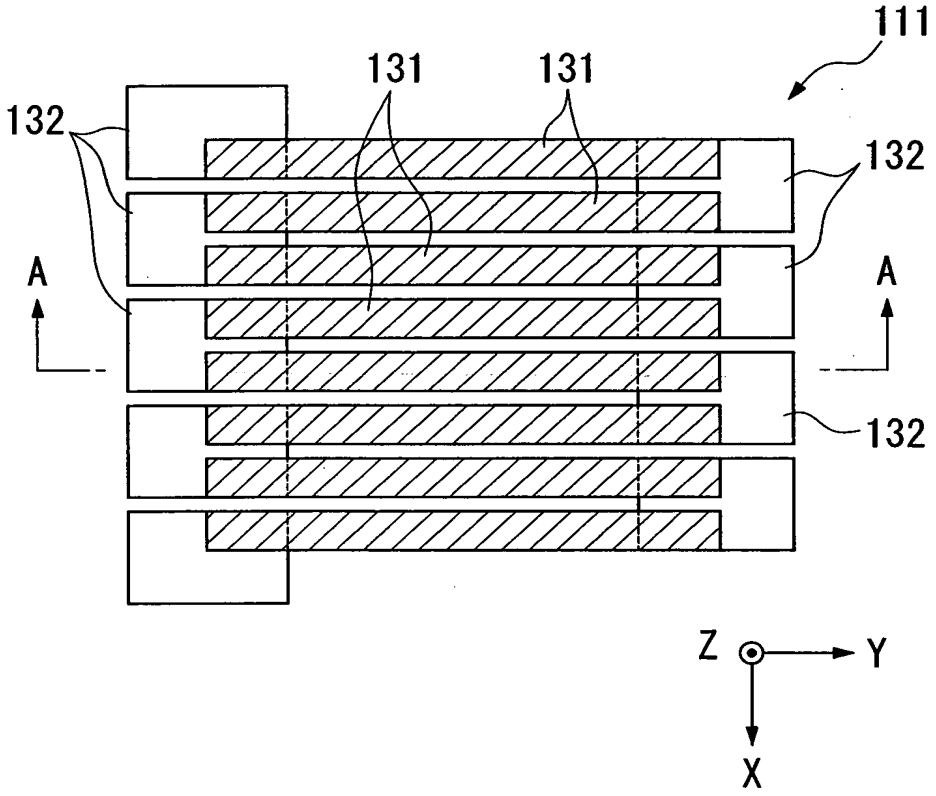

FIG. 28

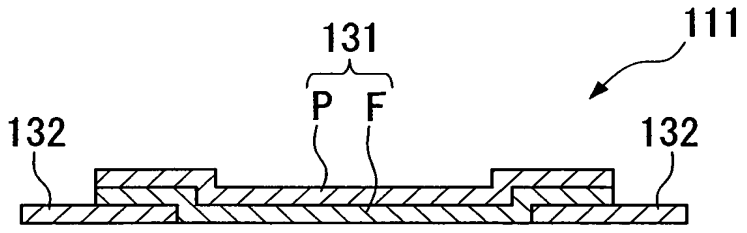

FIG. 29

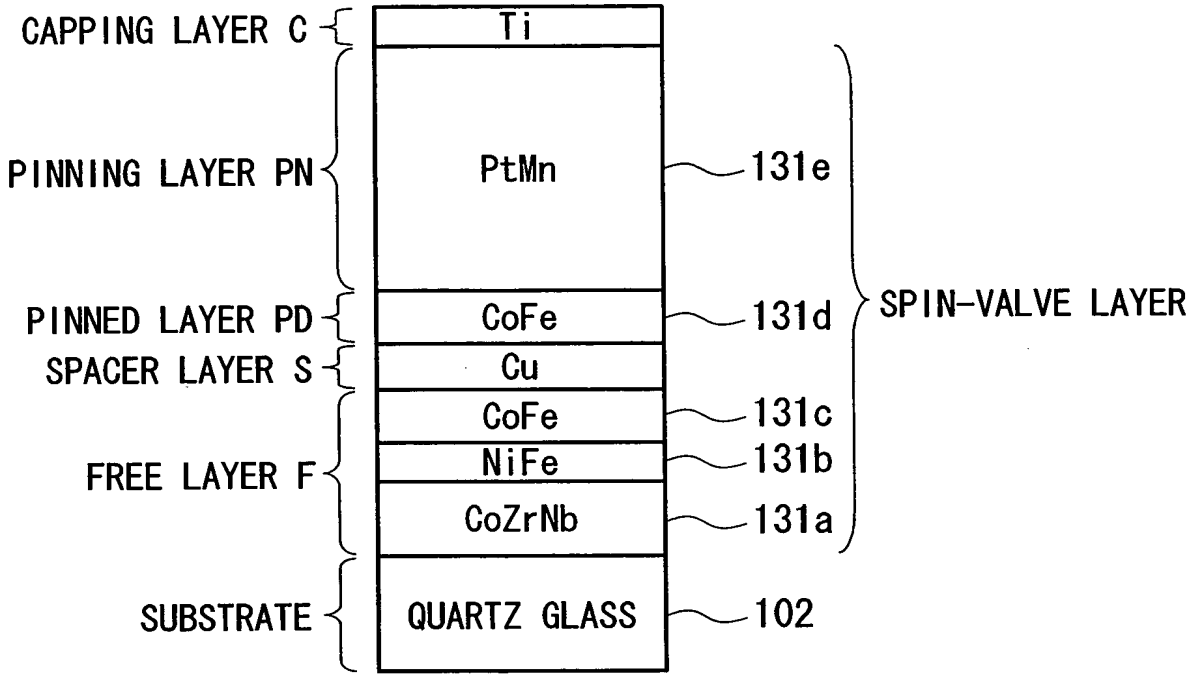
CAPPING LAYER C
Ti
PINNING LAYER PN
PtMn
131e
PINNED LAYER PD
CoFe
131d
SPIN-VALVE LAYER
SPACER LAYER S
Cu
FREE LAYER F
CoFe
131c
NiFe
131b
CoZrNb
131a
SUBSTRATE
QUARTZ GLASS
102

FIG. 30

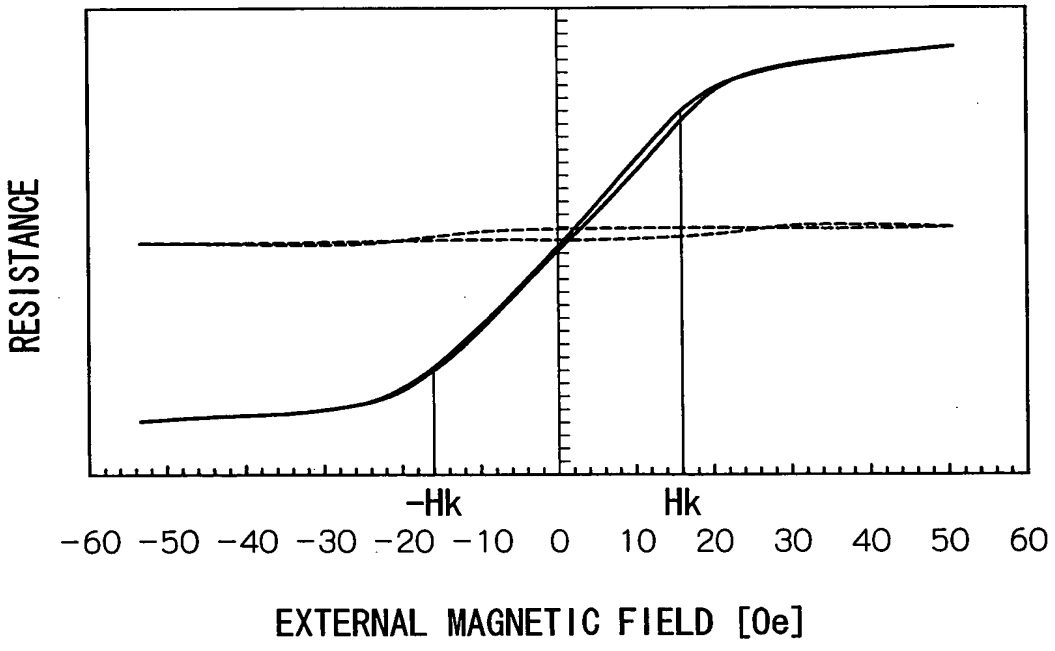
RESISTANCE
-Hk
Hk
-60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60
EXTERNAL MAGNETIC FIELD [Oe]

FIG. 31

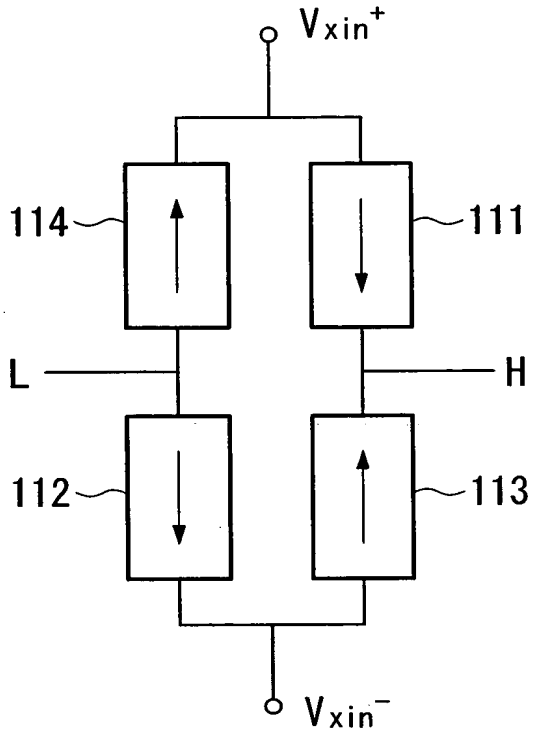
Vxin+
114
111
L
H
112
113
Vxin−

FIG. 32

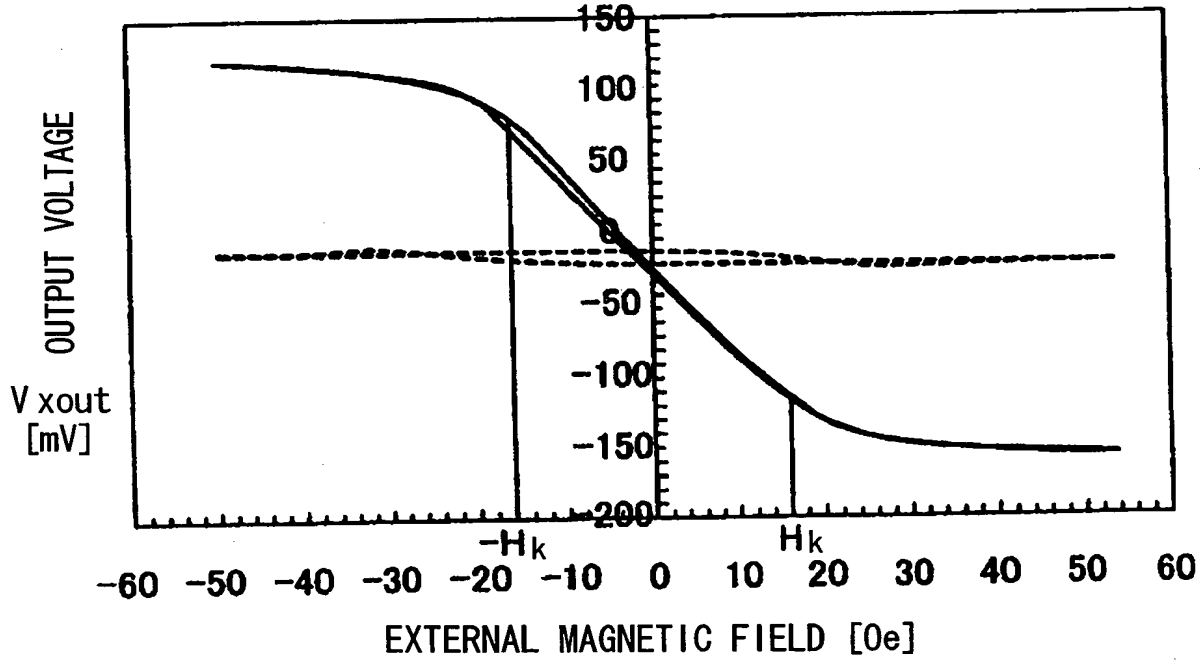
150
100
50
-50
-100
-150
-200
OUTPUT VOLTAGE
V xout
[mV]
-Hk
Hk
-60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60
EXTERNAL MAGNETIC FIELD [Oe]

FIG. 33

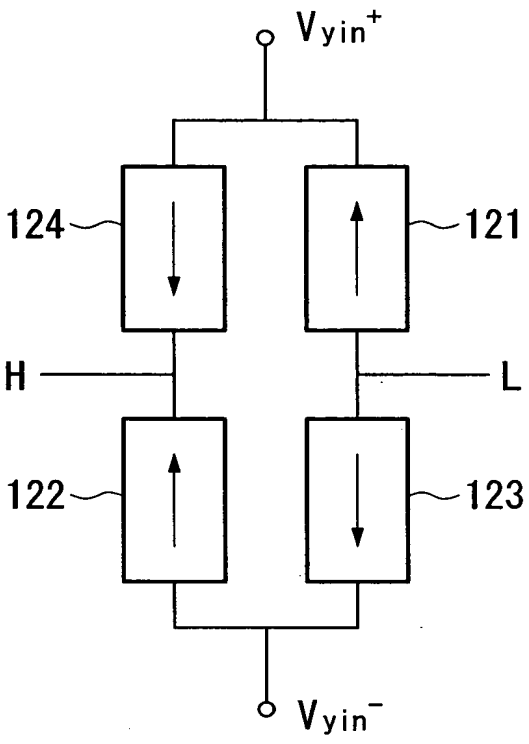
Vyin+
124
121
H
L
122
123
Vyin−

FIG. 34

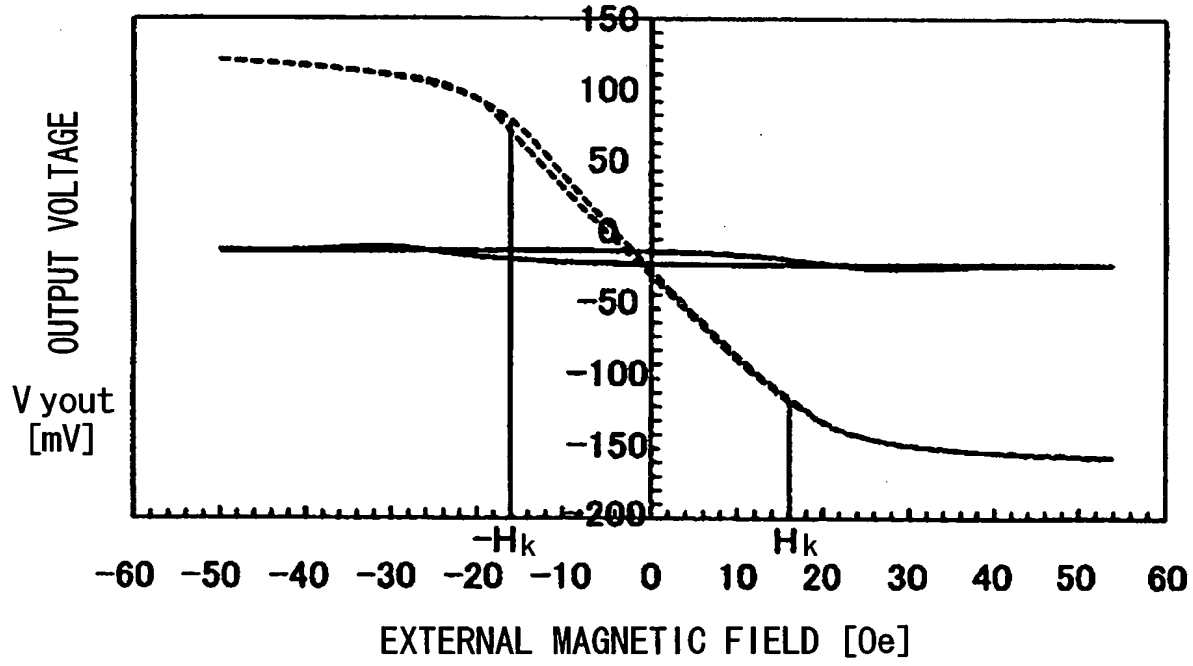
OUTPUT VOLTAGE
Vyout [mV]
150
100
50
0
-50
-100
-150
-200
-Hk
Hk
-60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60
EXTERNAL MAGNETIC FIELD [Oe]

FIG. 35

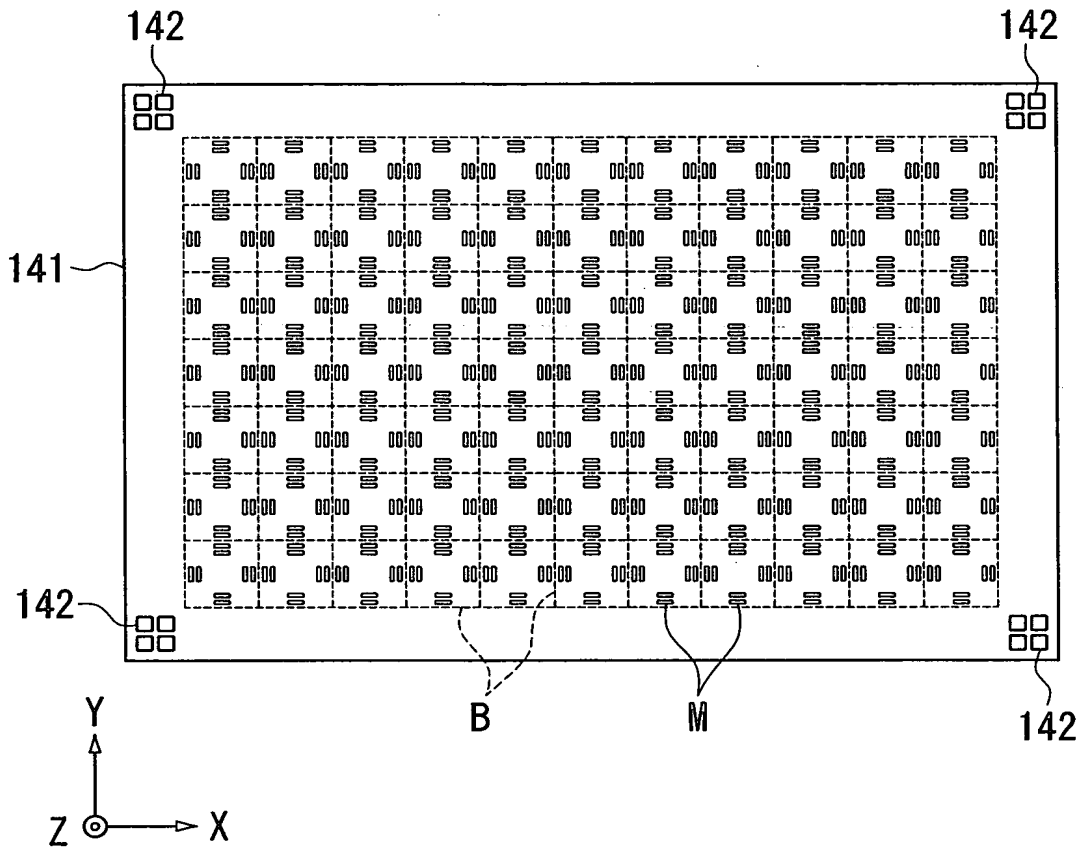

FIG. 36

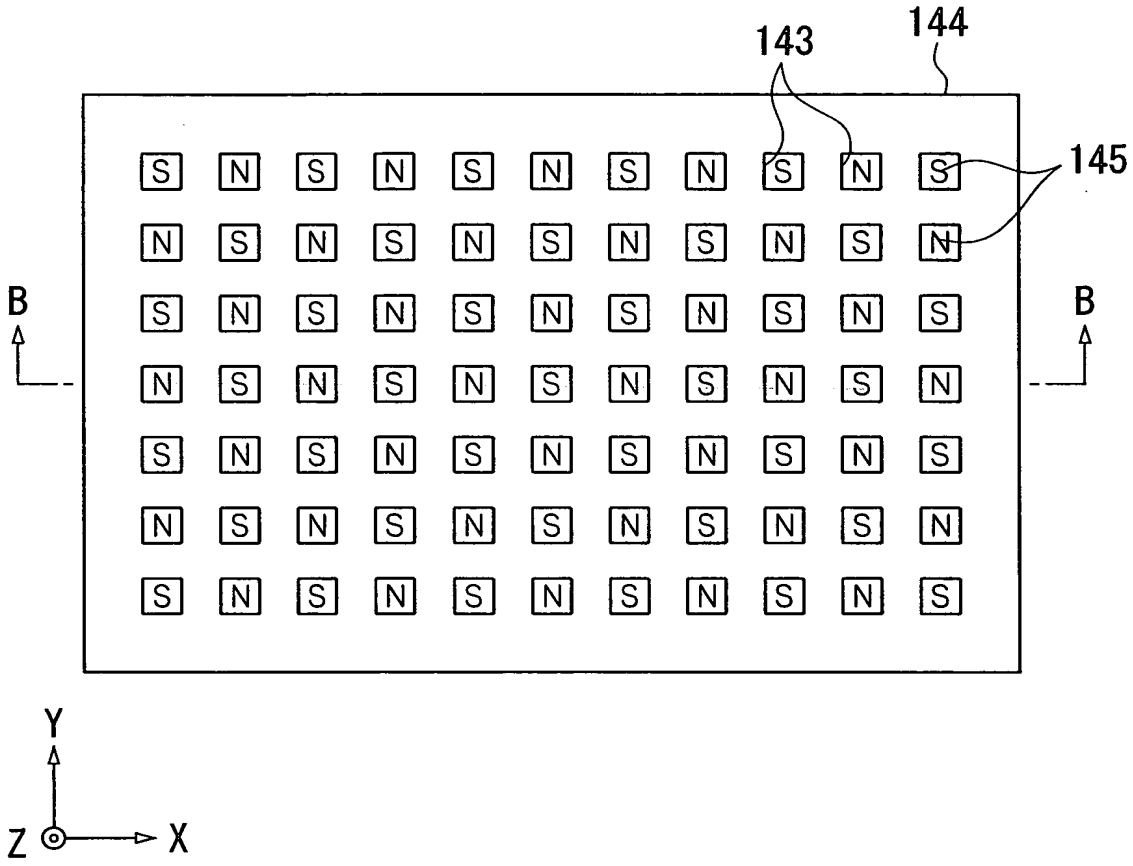
143
144
145
B
B
S N S N S N S N S N S
N S N S N S N S N S N
S N S N S N S N S N S
N S N S N S N S N S N
S N S N S N S N S N S
N S N S N S N S N S N
S N S N S N S N S N S
Y
Z
X

FIG. 37

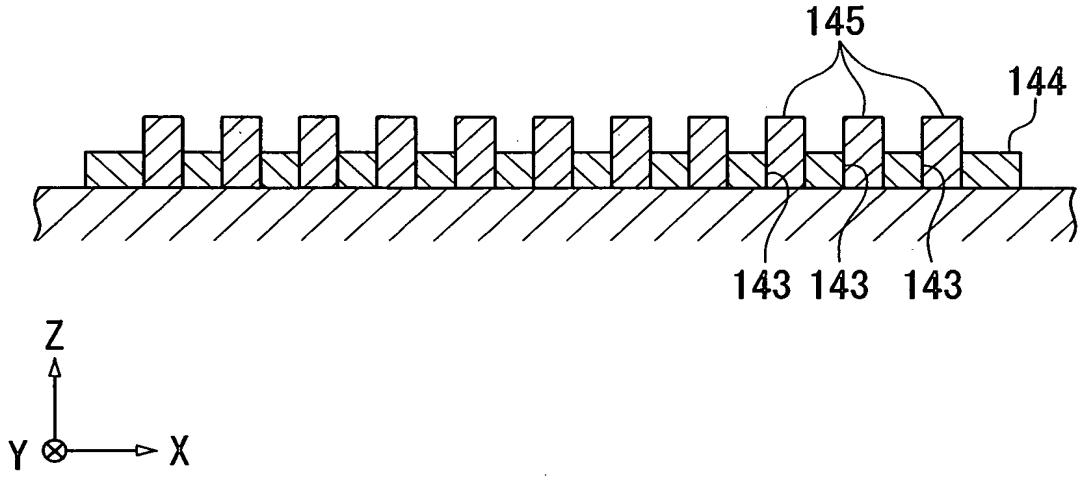
145
144
143 143 143
Z
Y
X

FIG. 38

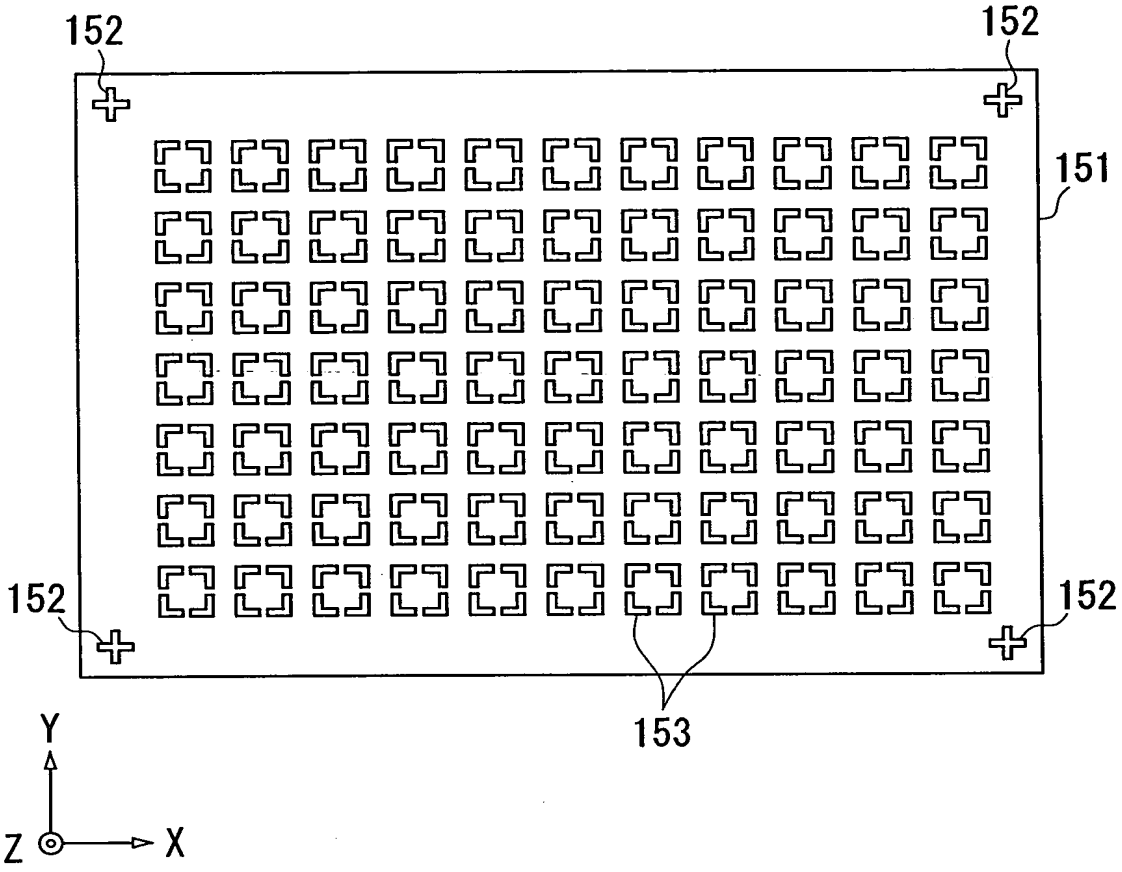

FIG. 39

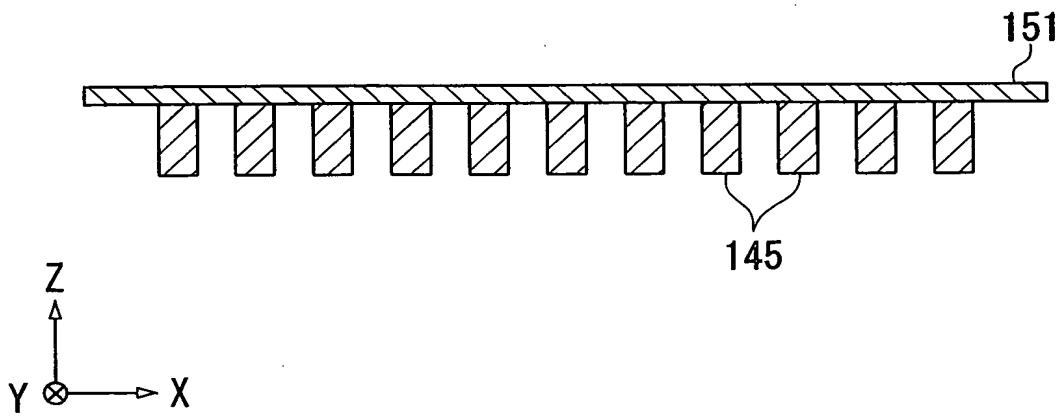

FIG. 40

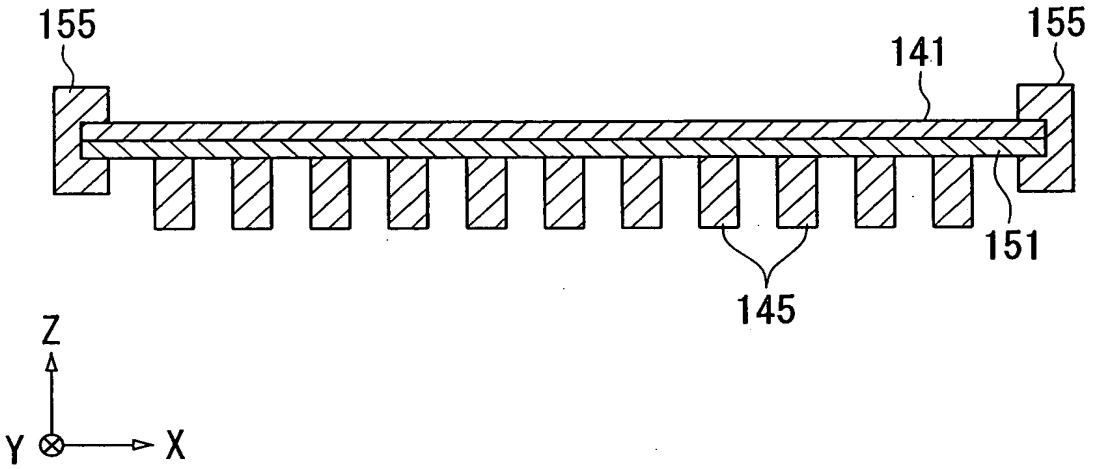

FIG. 41

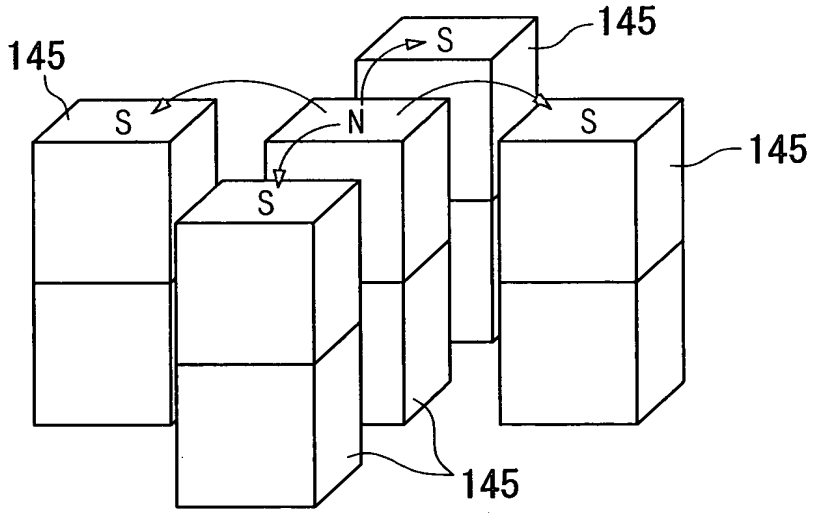

FIG. 42

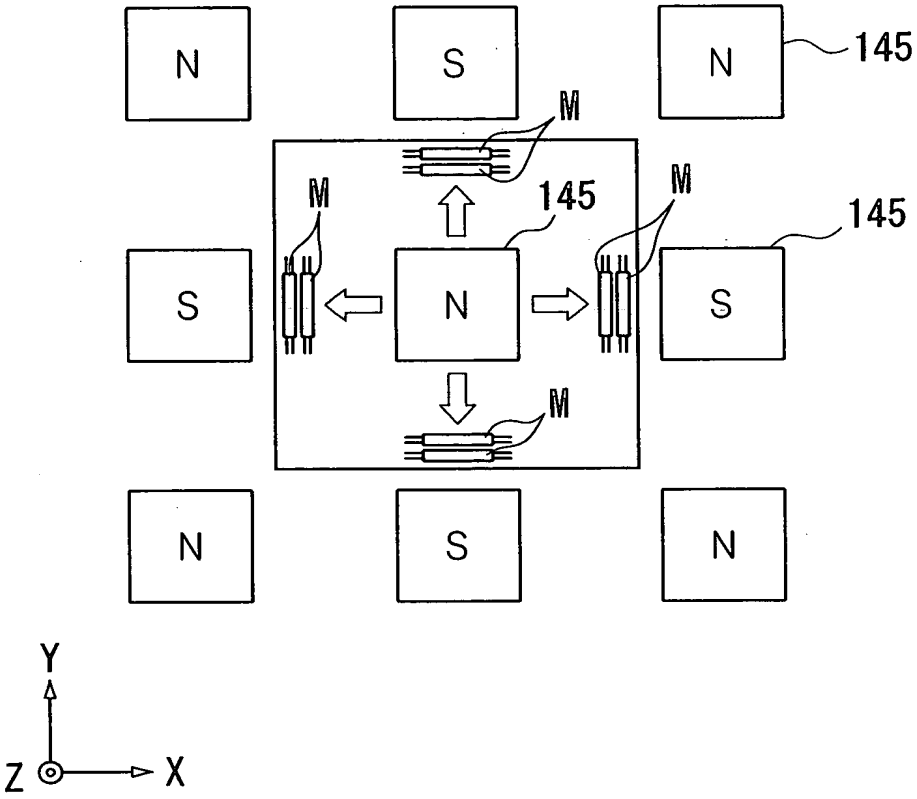

FIG. 43

	COMPARATIVE EXAMPLE		EMBODIMENT 1	EMBODIMENT 2	EMBODIMENT 3	EMBODIMENT 4	EMBODIMENT 5
PROCESS	POST	FINAL	FINAL	FINAL	FINAL	FINAL	FINAL
SENSITIVITY (mV/Oe)	4.1	3.6	1.8	2.0	1.8	0.95	0.90
OFFSET VARIATIONS AFTER EXPOSURE OF 100 Oe (mV)	0.082	0.288	0.036	0.059	0.072	0.028	0.036
VARIATION RATIO TO SENSITIVITY (%)	2	8	2	3	4	3	4
OFFSET TEMPERATURE VARIATIONS (mV/°C)	—	0.018	0.009	0.0044	0.0036	0.0018	0.0015
RATIO TO SENSITIVITY OF TEMPERATURE VARIATIONS (%)	—	0.5	0.5	0.22	0.2	0.19	0.17

App No.: Not Yet Assigned
Inventor: Hideki Sato, et al.
Title: MAGNETIC SENSOR AND MANUFACTURING METHOD THEREFOR
Docket No.: X2007.0144